

COS 598: Image Processing

Instructor: Doctor Terry Yoo

By: Nicholas Soucy

Homework Assignment 1

Part 1

- 1) My full name is Nicholas Soucy, I can be called Nick, Nicholas, or Soucy.
- 2) I went to UMaine for a undergraduate degree in Physics.
- 3) I am trying to get a M.S. in Computer Science.
- 4) Here are all the COS classes I took:
 - a. COS 125: It was Java
 - b. COS 140: Foundations of Com Sci
 - c. COS 225: Java II
 - d. COS 312: Intro to video game programming with Unity. VERY fun course!
 - e. COS 135: Applied C Programming
 - f. COS 226: Intro to Data Structures
 - g. COS 250: Discrete Structures
 - h. COS 331: Operating Systems
 - i. COS 235: Computer Architecture
 - j. COS 350: Data Structures & Algorithms
 - k. COS 598: Statistical Foundations of Data Science
 - l. COS 598: Computer Vision!
 - m. COS 554: Algorithms
 - n. COS 598: Machine Learning
 - o. COS 570: Artificial intelligence
 - p. COS 598: Introduction to Data Science
- 5) I took a good amount of math classes, here they are:
 - a. MAT 126: Calc 1
 - b. MAT 127: Calc 2
 - c. MAT 228: Calc 3
 - d. MAT 262: Linear Algebra
 - e. MAT 259: Differential Equations
 - f. Physics classes like optics, general relativity, etc. that had lots of math
- 6) He/they
- 7) Thankfully no!

Part 2

This semester I am hopefully finishing my MS in Computer Science, Thesis track with my advisor being Salimeh. For my thesis, I am working through the Sekeh Lab creating semantic segmentation models for

hyperspectral data working through INSPIRES. INSPIRES is a multicollegiate and multidisciplinary NSF funded academic group which works on big data forestry. I actually work in the same theme as Peter Nelson, who will be presenting later this semester. Here is a short summary of the overview of my thesis:

Tree species classification is a growing need in the world. Between climate change, invasive species, and logging enterprise, it is more important than ever to know which trees are where. Classifying trees by species can do things from reducing the ecological impact of logging enterprise to allowing researchers to prevent Ash trees from getting affected by the Emerald Ash Borer. Thankfully, due to the wide spread use of UAVs and satellite imagery, we have the hyperspectral data needed to classify tree species from pictures alone on a grand scale.

Tree species classification is a difficult problem in hyperspectral image (HSI) classification. Trees in a natural forest environment are overlapping, diverse, and diffused. This is a fundamentally different problem than most HSI classification that is done in machine learning (ML) and remote sensing today due to the available fully labeled datasets most researchers use in this field.

Raw HSI datasets often has around 200 features (also called bands, or light bands) and many samples (pixels) due to the size of images taken. These images can often encompass hundreds of square miles of land. Therefore, we wish to explore dimensionality reduction techniques that can effectively select pertinent features in the data for later classification in traditional and cutting-edge deep learning classifiers; thereby reducing runtime complexity and storage size for classification, while maximizing overall classification accuracy.

Work in HSI classification seems to be splintered between the fields of ML and Remote sensing. We work to bring the fields together by comparing many techniques, while also debuting U-Net to HSI classification in addition to introducing a competitive clustering ensemble U-Net (CE U-Net).

Our combined model is split into two parts, 1) Feature Extraction and 2) Classification. In each part, we explore a variety of techniques to find the best combination to reduce more features from the data to decrease runtime, while maintaining competitive accuracy.

1) Feature Extraction

For feature extraction, we use raw data and PCA as our baseline feature extraction to compare to our three CNN-based techniques. For this, we created our own 2D and 3D convolutional autoencoder architectures for feature extraction/dimensionality reduction.

2) Classification

For classification, we use our own U-Net and Clustering Ensemble U-net as our flagship CNN classifiers. All classification techniques use the output from the encoder (the reduced-feature data) or the output of principal component analysis (PCA) as input.

Part 3

- 1) I use Windows and Linux operating systems. I am intimately familiar with both as I use them regularly, but I use Windows for working.

- 2) I do not have access to Adobe Photoshop, but if you want to give me a license I would love that!
- 3) For the past two years I have been coding in Python everyday so currently that is my strongest language. My other stronger languages are: C, C#, SQL, LISP, Java, and C++.
- 4) As a COS Master's student doing my thesis in Machine Learning I have found that about 60% (if not more) of my coding time is image processing with about the other 40% being about the actual networks! Therefore, I wish to develop techniques in image processing to better apply to my thesis work and future industry positions.
- 5) I currently do not have a concrete idea for a image processing project, but I believe Mac and I are going to figure something out soon.